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Ecological Description and Classification of Some Pine Mushroom (*Tricholoma magnivelare*) Habitat in British Columbia

Shannon M. Berch and Alan M. Wiensczyk

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ABSTRACT

The purpose of this study is to describe the ecological characteristics and forest site classification of pine mushroom habitat in British Columbia. Soil, vegetation, and forest descriptions were made across six areas of the province known to support commercial crops of pine mushrooms: the Nass and Shumal river valleys near New Aiyansh, the Chilcotin Plateau, the Bella Coola Valley, the Columbia River Valley (Upper Arrow Lake) near Nakusp, the Lillooet River Valley near Pemberton, and the Nahatlatch Valley near Boston Bar. Forest subzone, elevation, slope, aspect, and landform all varied between study sites. However, soil moisture and nutrient regimes fell within a relatively narrow range. Soil moisture was in almost all cases drier than average for the subzone (subxeric–submesic: 2–3), and soil nutrient regimes fell almost exclusively within the range of poor to medium (B–C). Soils tended to be well or rapidly drained, with an Ae horizon, coarse soil texture (sand to loamy sand), and often a high coarse fragment content. Forest floors tended to be relatively thin, and wildfire was the most common natural disturbance regime. The most consistent tree species was western hemlock (*Tsuga heterophylla*), with lodgepole pine (*Pinus contorta* var. *latifolia*) and Douglas-fir (*Pseudotsuga menziesii* var. *glauca*) sometimes present. Shrub and herb species tended to have relatively low cover values, while moss cover was highly variable, ranging from 7 to 97%. In general, the soil, vegetation, and forest stand results indicate that submesic site series correlate well with pine mushroom habitat. This consistency in habitat across forest subzones should allow forest managers to better recognize and consider potential commercial mushroom ground in development plans.

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This research report contains information on the ecology and management of non-timber forest products. In promoting implementation of this information the user should recognize the equitable sharing of benefits derived from the management and use of this product (Article 8(j) of the United Nations Convention on the Conservation of Biological Diversity). Where possible, the reader should involve the keepers of this knowledge and encourage customary use of biological resources in accordance with traditional cultural practices that are compatible with the conservation and sustainable use requirements (Article 10 (c)).

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1 General location in British Columbia of the pine mushroom study areas included in this report 2

INTRODUCTION

The pine mushroom (*Tricholoma magnivelare* (Peck) Redhead) is the most economically important species of wild mushroom commercially harvested from the forests of British Columbia (deGeus 1995; Wills and Lipsey 1999), the Pacific Northwest (Amaranthus and Pilz 1996; Hosford et al. 1997), and Mexico (Bandala et al. 1997). It also occurs in eastern Canada (Redhead 1997). Many groups and individuals are concerned about the future of this non-timber forest product (e.g., deGeus 1995; Pilz et al. 1996; deGeus and Berch 1997; Redhead 1997). The pine mushroom is an ectomycorrhizal forest fungus (Lefevre and Müller 1998) associated with commercially valuable conifer species. As this species of mushroom is dependent on an overstorey of living host trees, it is highly sensitive to timber harvesting practices. Given the goal of integrating pine mushroom management into forest management, information is needed on the types of forest stands and ecosystems in which pine mushroom occurs.

In January 1994, the Pine Mushroom Task Force recommended that scientific research on the ecology of the pine mushroom be undertaken (Integrated Resources Policy Branch 1995). In response, a study was launched in 1994 with the establishment of three research plots near New Aiyansh, British Columbia (Trowbridge and Macadam 1996). The objective of the study was to describe the ecological characteristics (site attributes, soil profiles, and vegetation communities) of areas known to support commercial crops of pine mushrooms. In 1996, the study was expanded to include 15 plots representing five other areas. This research report documents the results of the study from all six areas.

The study areas selected are known to be "hot spots" for pine mushroom harvesting (deGeus 1995). Within each area, experienced pine mushroom pickers were used to select sample locations. Given the high number of mushroom pickers and the high value of their crop, it is believed that most of the accessible and productive pine mushroom sites are known. The areas sampled in this study are believed to be representative of these sites.

METHODS

STUDY AREA

Plots were established in six areas of the province known to support commercial crops of pine mushrooms (Figure 1): the Nass and Shumal river valleys near New Aiyansh, the Chilcotin Plateau, the Bella Coola Valley, the Columbia River Valley (Upper Arrow Lake) near Nakusp, the Lillooet River Valley near Pemberton, and the Nahatlatch Valley near Boston Bar.

LOCATION AND MARKING OF STUDY PLOTS

In each study area, experienced local pine mushroom pickers or others with local knowledge assisted in the random location of three 25 × 25-m plots in ecosystems typical of highly productive pine mushroom habitat. The Nass Valley plots, established in 1994, were revisited in the fall of 1995 for data collection. The

FIGURE 1 *General location in British Columbia of the pine mushroom study areas included in this report.*

remainder of the study plots were established and data collection completed in the fall of 1996.

The majority of the study plots were accessible by road with the exception of the Nass Valley plots, which were accessible by foot or by helicopter only.

Plots were marked using various methods (e.g., staked corners) to allow for re-assessment.

ECOSYSTEM DESCRIPTIONS

Standard reconnaissance procedures (Luttmerding et al. 1990) were used to describe site characteristics, vegetation, and soils in each plot. Biogeoclimatic site series and phases were classified using the field guides for the appropriate forest region based on site location. A provisional site series classification provided by Ordell Steen (B.C. Ministry of Forests, Cariboo Forest Region) was used for the ESSFxv1 variant at the Chilcotin Plateau site. At the Nass River, Chilcotin Plateau, and Bella Coola Valley study sites standard Ministry of Forests FS822 forms were used to record the data. Ministry of Forests FS711A forms were used at the Nakusp study site. Forms adapted from the 1995 Vegetation Resources Inventory were used to collect the site attribute and vegetation data at the Nahatlatch and Pemberton study sites.

In each plot, the species of vegetation and their percent cover were recorded for each of the following layers: trees, shrubs, herbs, and mosses, lichens, liverworts, and seedlings. The combined percent cover of all species for each layer was also documented. Plant names corresponded to those used in *The Vascular Plants of British Columbia* (Douglas et al. 1989, 1990, 1991, 1994). Photographs were taken of the typical understorey layer at several locations in each plot. Plots were also surveyed for the presence of pine mushroom fruiting bodies.

At the Nakusp study site, one tree from each species and layer was sampled for age. The total height and height to live crown were also estimated. In addition to the 25 × 25-m plot, one variable radius plot using a 4 Basal Area Factor (BAF) prism was established near the centre of the main plot to estimate basal area and stand volume. One representative stem of each species within the variable radius plot was sampled for age and measured for height.

Soil pits were excavated to a depth of at least 60 cm. To minimize disturbance, the soil was placed on a tarp and later replaced following the description and sampling of the soil profile. Landforms were described according to the *Terrain Classification System for British Columbia* (Howes and Kenk 1988), soil pedons following *The Canadian System of Soil Classification* (Agriculture Canada Expert Committee on Soil Survey 1987), and humus forms using *Towards a Taxonomic Classification of Humus Forms* (Green et al. 1993). Photographs of the soil profile were taken and a soil profile diagram was drawn of the Nass River, Chilcotin Plateau, Bella Coola Valley, and Nakusp study sites. The description of soils at the Nahatlatch and Pemberton plots was minimal and no samples were collected for chemical analysis.

The fieldwork for this study was done by three different contractors, each with their own strengths and interests. This accounts for the inconsistencies in emphasis between the descriptions of the various sites.

SOIL CHEMICAL ANALYSIS

At the Nass River, Chilcotin Plateau, Bella Coola Valley, and Nakusp study sites, representative soil samples were collected from each soil horizon and sent to the B.C. Ministry of Forests Research Branch Laboratory in Victoria for analysis. The analysis methods used are described in Page et al. (1982), except where indicated. Soil pH was determined from suspensions of soil and 0.01 M $CaCl_2$. Total carbon (C) and nitrogen (N) were measured using a Leco induction elemental analyzer. Available phosphorus (P) was extracted with acid-fluoride (Bray 1) and analyzed colourimetrically on a UV/visible spectrophotometer. Cation exchange capacity (CEC) and exchangeable calcium (Ca), magnesium (Mg), and potassium (K) were determined by the $NH_4OAc/pH7$ method. Released NH_4, used to estimate CEC, was determined by colourimetric analysis using a Technicon Autoanalyzer, and the cations were determined by ICAP spectrophotometry. Mineralizable N was estimated through a 2-week anaerobic incubation at 30°C, followed by a 1N KCl extraction and colourimetric analysis for ammonium N. Extractable Fe and Al were both determined following methods outlined in Bascomb (1968).

RESULTS

SITE AND ECOSYSTEM CLASSIFICATIONS

The study plots were found to encompass eight different subzones or variants within five biogeoclimatic zones: Interior Cedar-Hemlock (ICH), Sub-Boreal Pine–Spruce (SBPS), Engelmann Spruce–Subalpine Fir (ESSF), Interior Douglas-fir (IDF), and Coastal Western Hemlock (CWH) (Table 1). The general environmental characteristics of these biogeoclimatic zones, subzones, and variants are described in *Ecosystems of British Columbia* (Meidinger and Pojar 1991) and in other site identification and interpretation field guides (Braumandl and Curran 1992; Banner et al. 1993; Green and Klinka 1994; Steen and Coupé 1997).

Nass River

The Nass River study area was located at the western edge of the ICH zone (Banner et al. 1993), on lower and mid-slope positions near the Shumal and Nass rivers in British Columbia. To the west and at higher elevations, the study area borders on the CWH zone. Physiographically, the area is in a transitional zone between the Skeena and Coast mountain ranges, and between the Boundary and Kitimat ranges, where the westernmost section of the Nass Basin extends along the Nass River (Holland 1976).

The plots (NS-1, NS-2, and NS-3) were found within the submesic phase of the Hw–Step moss site series of the Moist Cold subzone, Hazelton variant (ICHmc2/01b) (Banner et al. 1993) (Table 1), which is the warmest and driest variant of the ICHmc subzone. The plots were located on different benches distributed along an elevational transect (approximately 100–500 m above sea level) on very gentle to moderate slopes; all of the benches had roughly southeasterly aspects.

The NS-1 and NS-2 plots were situated on coarse-textured glaciofluvial terraces, and the NS-3 plot was on a coarse-textured morainal till. Soil development was also similar among the plots with Hemimor humus forms on pedons classified as Eluviated Dystric Brunisols or Orthic Humo-Ferric Podzols.

TABLE 1 *Summary of environmental and ecological attributes for pine mushroom study plots, grouped by study area*

Attribute	Plot	Nass	Chilcotin	Bella Coola	Nahatlatch	Pemberton	Nakusp
Biogeoclimatic and ecological classification	1	ICHmc2/01(1)b	SBPSxc/02	IDFww/03	IDFww/01	CWHds1/03	ICHmw2/01(04)
	2	ICHmc2/01(1)b	SBPSxc/02	CWHds2/01	CWHds1/03	IDFww/01	ICHmw2/01(05)
	3	ICHmc2/01(1)b	ESSFxv1/02	CWHds2/03	CWHms1/03	IDFww/01	ICHmw2/01(04)
Soil moisture/nutrient regimes	1	2/B	2–/B	2/C–	4/C	5°/C	4(3)/A–B
	2	2+/B	2/B	3/B	3/C	3/C	4–5°/B–C
	3	3/B	3–/B	2/B	3/C	3/C–D	4/B–C
Dominant (and sub-dominant) tree species	1	Pl	Pl	Fd	Fd (Cw Pl)	Hw (Cw)	Hw Fd (Cw)
	2	Pl (Hw)	Pl	Fd	Pl (Fd)	Fd (Cw H^{L}w)	Fd Cw (Hw)
	3	Hw (Pl)	Pl (Bl)	Pl Fd	Fd	Fd	Hw (Pa Cw)
Latitude/ Longitude	1	55°14.8'/129°9'	52°03'/124°55'	52°23'/126°01'	49°56.5'/121°55.9'	50°32.8'/122°32.8'	50°21.8'/117°52.9'
	2	55°15.5'/129°9.9'	52°10'/125°15'	52°25'/126°12'	49°56.3'/121°54'	50°33.3'/122°34'	50°04.3'/117°59.2'
	3	55°15.5'/129°11.1'	52°30'/125°50'	52°26'/126°23'	49°57.4'/121°40.8'	50°27'/122°41.2'	50°23'/117°57'
Elevation (m)	1	110	960	455	400	610	725
	2	195	1195	195	425	730	655
	3	516	1320	110	1000	420	595
Slope (%) and aspect	1	3, E–SE	10, E–NE	46, E–SE	30, S	21, NE	25, W
	2	13, S–SE	0–1, no aspect	3, SW	54, NE	14, S–SE	20–45, E
	3	19, SE	0, no aspect	0–2, SE	68, W	7, S	10, S
Landform	1	Glacio-fluvial terrace	Eolian blanket	Colluvial/fluvial blanket	NA	NA	Moraine
	2	Glacio-fluvial terrace Morainal till	Glacio-fluvial blanket	Fluvial terrace			Moraine
	3		Morainal veneer over bedrock	Fluvial terrace			Glacio-lacustrine terrace
Soil classification	1	Orthic Humo-Ferric Podzol	Orthic Dystric Brunisol	Orthic Eutric Brunisol	NA	NA	Eluviated Dystric Brunisol
	2	Orthic Humo–Ferric Podzol	Orthic Dystric Brunisol	Orthic Dystric Brunisol			Eluviated Dystric Brunisol
	3	Eluviated Dystric Brunisol	Orthic Humo–Ferric Podzol	Orthic Humo–Ferric Podzol			Eluviated Dystric Brunisol

Humus form classification	1	Hemimor	Crustic–Melic Hemimor	Melic Hemimor	NA	NA	Hemimor
	2	Hemimor	Velic Hemimor	Tenuic Hemimor			Hemimor
	3	Hemimor	Tenuic Hemimor	Tenuic/melic Hemimor			Hemimor
Soil texture	1	Loamy sand to sand	Sand	Loamy sand	Sandy loam	Silty loam	Silty loam
	2	Loamy sand to sand	Sand	Sand to (fine) sandy loam	Sand	Silty loam	Sandy loam
	3	Sandy loam to loamy sand	Loamy sand	Sand to loamy sand	Loamy sand	Loamy sand	Loamy sand
Course fragment content (%)	1	30–80	0	25–50	35	60	30–65
	2	22–55	3–30	0	60	60	25–50
	3	20–45	45–65	35–65	35–55	40	5–10
Soil drainage	1	Rapid	Well–rapid	Well–rapid	Well	Well	Moderate
	2	Rapid	Well–rapid	Well–rapid	Well	Well	Rapid
	3	Well–rapid	Well–rapid	rapid	Well	Well	Rapid

a Given the other soil attributes recorded for this plot, the soil moisture regime indicated is suspected as being too high.
NA Information not available.

KEY TO TABLE 1

Biogeoclimatic zones	Subzones and variants	Dominant (and sub-dominant) tree species
CWH: Coastal Western Hemlock	ds1: Dry Submaritime, Southern variant	Pl: Lodgepole pine (*Pinus contorta* var. *latifolia*)
ICH: Interior Cedar-Hemlock	ds2: Dry Submaritime, Central variant	Hw: Western hemlock (*Tsuga heterophylla*)
IDF: Interior Douglas-fir	mc2: Moist Cold, Hazelton variant	Cw: Western Redcedar (*Thuja plicata*)
ESSF: Engelmann Spruce–Subalpine Fir	ms1: Moist Submaritime, Southern variant	Fd: Douglas-fir (*Pseudotsuga menziesii* var. *glauca*)
SBSP: Sub-Boreal Pine–Spruce	mw2: Moist Warm, Columbia-Shuswap variant	Pa: Whitebark pine (*Pinus albicaulis*)
	ww: Wet Warm	Bl: Subalpine fir (*Abies lasiocarpa*)
	xc: Very Dry Cold	
	xv1: Very Dry Very Cold, West Chilcotin variant	

Chilcotin Plateau and Bella Coola Valley

The Bella Coola Valley sites (B-1, B-2, and B-3) were located in the Pacific Ranges of the Coast Mountains, while two of the Chilcotin Plateau sites (C-1 and C-2) were on the Fraser Plateau of the Interior Plateau (Holland 1976). The third Chilcotin Plateau site (C-3) was transitional between the Interior Plateau and the Coast Mountains (Holland 1976). The six sites were located along an east to west transect, and included four different climatic conditions, represented by four biogeoclimatic subzones and variants: the SBPSxc, ESSFxv1, IDFww, and CWHds2 (Table 1). Two of the Bella Coola Valley sites (B-2 and B-3) are within the Dry Submaritime subzone, Central variant, of the CWH zone (CWHds2) (Green and Klinka 1994). The third site (B-1) is located within the Wet Warm subzone of the IDF zone (IDFww) (Green and Klinka 1994). Two of the Chilcotin Plateau sites (C-1 and C-2) are within the Very Dry, Cold subzone of the SBPS zone (SBPSxc), while the third (C-3) is within the Very Dry, Very Cold subzone, West Chilcotin variant, of the ESSF zone (ESSFxv1) (Steen and Coupé 1997).

The plot elevations ranged from approximately 100 to 1300 m above sea level. The relative soil moisture and nutrient regimes were generally drier and poorer than zonal ecosystem concepts. Although the landforms varied, the soil pedons were all coarse textured, ranging from sand to sandy loam, and well to rapidly drained.

Nakusp

The Nakusp study area was located in the West Kootenay area of British Columbia, within the Nelson Forest Region and Arrow Forest District. Study plots were located on lower to mid-slope positions in the Columbia River Valley (Upper Arrow Lake) and an associated side drainage (Mosquito Creek). All of the plots were located within Tree Farm Licence (TFL) 23, held by Pope and Talbot Ltd. The plots (N-1, N-2, and N-3) were located within the Moist Warm subzone, Columbia-Shuswap variant, of the ICH zone (ICHmw2) (Braumandl and Curran 1992) (Table 1). Plots N-1 and N-3 were located on submesic sites, and the N-2

plot was located on a mesic–subhygric[1] site. Plot N-1 was located on a morainal blanket composed of glacial parent material. The plot was situated at the mouth of a very small ephemeral drainage on a moderate (25–30%) slope. Fluvial activity from this small drainage was extremely minor as no firm evidence of material sorting or hydrologic weathering could be detected within the soil pit. Sub-angular coarse fragments mixed with fine silts indicate that materials in and around this plot were probably deposited by glacial processes.

Plot N-2 was located on a morainal blanket composed of glacial parent material. The plot was situated within a sharp gully with 43–65% side slopes and had a small creek running through its centre. With a gradient of 20%, this creek has moved large amounts of soil from the site and continues to remove fine material from the streambed. As with plot N-1, sub-angular course fragments intermixed with fine sands and silts indicated glacial deposition.

Plot N-3 was located on a glacio-lacustrine terrace in a mid-slope position above Upper Arrow Lake. The general topography consisted of wide, flat benches (10% slope) with short steep (40% slope) breaks. Extensive sorting of the soil materials (loamy sand with a coarse fragment content under 10% throughout the soil profile) indicated that deposits within this area were lacustrine in origin. The position of the area at mid-slope above the current lake level was possibly due to a build-up of lacustrine sediments behind a partially retreated glacier.

1 Plot N-2 was reported to have a soil moisture regime of 4–5 (mesic–subhygric), but with rapid soil drainage. Further field work is required to verify the accuracy of the soil moisture regime for this plot.

Nahatlatch and Pemberton

The study sites in the Pemberton and Nahatlatch areas were located in the rain shadow of the Coast Mountains where the IDF reaches its westernmost limits and the distribution of IDFww is mainly along valley bottoms and southwest-facing slopes. The climate in all three of these subzones is transitional between interior and maritime.

The Pemberton study area was located in the lower elevations of the Lillooet River Valley. This study area included the IDF Wet Warm subzone (IDFww) (P-2 and P-3) and the adjacent Dry Submaritime subzone, Southern variant, of the CWH zone (CWHds1) (P-1) (Green and Klinka 1994).

The Nahatlatch study area was located on lower and mid-slope positions along the Nahatlatch River Valley (tributary to the Fraser River). These three plots were in the IDFww (plot NH-1), CWHds1 (plot NH-2), and CWH Moist Submaritime–Southern variant (CWHms1) (plot NH-3) subzones (Green and Klinka 1994).

Three of the plots (NH-1, P-2, and P-3) were classified as site series 01 (FdCw–Hazelnut) within IDFww (Table 1). Each of the IDFww plots is on a gentle slope, near the valley bottom, with a near-south aspect. Plots NH-2 and P-1[2] were classified as site series 03 (FdHw–Falsebox) within CWHds1. Both plots are located on a northeast aspect with moderate slopes. The final plot, NH-3, was found on a steeper slope with an east aspect and was classified as site series 03 (FdHw–Falsebox) within CWHms1.

2 Soil moisture regime for plot P-1 was identified as 5 (subhygric), but the rest of the site attributes indicate a much drier site. Further fieldwork would be needed to verify this.

Fire history was evident in plots NH-1 and NH-2, where the soil pits revealed a residue of charcoal above the mineral soil. Plot NH-2 contained a maturing seral stand currently dominated by lodgepole pine (*Pinus contorta*) with Douglas-fir beginning to replace the lodgepole pine. The surficial material in plot NH-2 was 65% colluvium over a well-drained soil. Because a thick moss layer is highly developed on the rocks, with a significant accumulation of duff, the percent cover of the mosses in this plot includes mosses growing both on the colluvial substrate and the duff or mineral soil. Large boulders covered 40% of plot NH-3. The remaining substrate had a thin duff or bryophyte layer and exposed mineral soil. Estimates of percent cover on this plot exclude the rocky substrate as a non-dominant substrate. Coarse woody debris was a minor component of the Nahatlatch plot substrates.

Plot P-1 showed indications of past timber harvesting. This plot included at least 13 well-decayed stumps and an abundance of highly decayed coarse woody debris on the forest floor. The stand structure indicated that commercial thinning or selective harvest had occurred. Plot P-2 showed similar stand structure, although the dominant species were different. In addition to the coarse woody debris on the forest floor, a significant amount was suspended above the ground. The forest floor of plot P-3 was almost entirely duff, with only 2% coarse woody debris and no rocky substrates. Located near the Birkenhead River, plot P-3 had numerous game trails crossing the plot.

Nass River

The tree canopy was fairly dense and always included lodgepole pine (*Pinus contorta* var. *latifolia*) (Table 2). Western hemlock (*Tsuga heterophylla*) occurred in the tree layer of plots NS-2 and NS-3, but not NS-1. Western hemlock occurred in the shrub layer in all plots, and lodgepole pine was present in this layer in plots NS-2 and NS-3, but not NS-1. The presence of lodgepole pine is not characteristic of old-growth forests, but reflects a maturing seral successional status in the ICHmc2. No other tree species were observed within plot boundaries.

The shrub and herb layers were not rich in diversity. *Vaccinium membranaceum* and *V. parvifolium* were present in each plot, but with low percent cover. The presence of *V. parvifolium* is indicative of the transitional character of the study area, being a species more commonly associated with the CWH zone. Average percent shrub cover for all plots was only 7%. *Chimaphila umbellata* and *Goodyera oblongifolia* were the only herb species present in all plots, with similarly low percent cover values. The overall herb cover in all plots averaged 4%. The density of the tree canopy may, in part, account for the low shrub and herb cover observed. However, this low percent cover is not atypical of the poorly developed vegetation generally found on submesic and submesotrophic moisture and nutrient regimes in the ICHmc2.

Pleurozium schreberi was the dominant or co-dominant bryophyte species in each case, with *Hylocomium splendens* next in abundance. *Rhytidiopsis robusta* was present in each plot, with relatively low cover in NS-1 and NS-2 (6–10%), and higher cover (38%) in NS-3. Lichen species were rare or absent.

Chilcotin Plateau and Bella Coola Valley

Lodgepole pine was found in all three plateau sites (SBPS and ESSF) (Table 3), and Douglas-fir in all the valley sites (IDF and CWH) (Table 4). Total tree percent covers ranged from 35 to 85%, while shrub and herb layer percent covers were generally sparse.

Shepherdia canadensis, although having very low cover, was

TABLE 2 *Summary of the vegetation data for the Nass and Shumal rivers pine mushroom study plots (percent cover)*

Species	Layer[a]	Plot NS-1	Plot NS-2	Plot NS-3	Constancy[b]
Trees					
Pinus contorta var. *latifolia*	A	25	20	15	1.00
	B	—	25	10	0.67
	D	—	—	—	0.00
Tsuga heterophylla	A	—	10	35	0.67
	B	40	60	20	1.00
	D	3	15	—	0.67
Total tree layer[c]	**All**	**65**	**80**	**80**	**1.00**
Shrubs					
Alnus rubra	B	< 1	—	—	0.33
Menziesia ferruginea	B	—	1	< 1	0.67
Paxistima myrsinites	B	2	—	—	0.33
Rubus parviflorus	B	—	1	T[d]	0.67
Sorbus scopulina	B	< 1	—	T	0.67
Vaccinium membranaceum[e]	B	2	4	4	1.00
Vaccinium parvifolium	B	1	1.5	3	1.00
Total shrub layer	**B**	**6**	**7**	**8**	**1.00**
Herbs					
Chimaphila umbellata	C	< 1	1	2	1.00
Clintonia uniflora	C	—	—	< 1	0.33
Cornus canadensis	C	—	1	1	0.67
Goodyera oblongifolia	C	< 1	1	2	1.00
Linnaea borealis	C	—	1	—	0.33
Orthilia secunda	C	—	—	1	0.33
Pyrola asarifolia	C	—	< 1	< 1	0.67
Total herb layer	**C**	**1**	**6**	**6**	**1.00**
Mosses, lichens, liverworts, and seedlings					
Cladina spp.	D	1	—	—	0.33
Dicranum spp.	D	5	—	—	0.33
Hylocomium splendens	D	15	20	30	1.00
Peltigera spp.	D	< 1	—	—	0.33
Pleurozium schreberi	D	69	30	25	1.00
Ptilium crista-castrensis	D	—	5	2	0.67
Rhytidiadelphus triquetrus	D	—	10	—	0.33
Rhytidiopsis robusta	D	6	10	38	1.00
Total moss, lichen, liverwort, and seedling layer	**D**	**97**	**75**	**95**	**1.00**

a A = tree layer: includes dominant, co-dominant, and sub-canopy trees > 10 m in height; B = shrub layer: includes both tall and low shrubs < 10 m in height; C = herb layer; and D = moss, lichen, liverwort, and seedling layer (British Columbia Ministry of Environment, Lands and Parks and British Columbia Ministry of Forests 1998).

b Constancy refers to the proportion of plots in which the species were found.

c "Total" is the visual percent cover estimate, not the addition of all species percent cover.

d "T" = trace

e The *V. membranaceum* looked somewhat like *V. alaskaense* in that leaf margins were not consistently fine-toothed; however, other *V. alaskaense* characteristics were lacking.

TABLE 3 *Summary of the vegetation data for the Chilcotin Plateau pine mushroom study plots (percent cover)*

Species	Layer[a]	Plot C-1	Plot C-2	Plot C-3	Constancy[b]
Trees					
Abies lasiocarpa	A	—	—	5	0.33
	B	—	—	12	0.67
Picea glauca	D	—	T[d]	—	0.33
Pinus albicaulis	D	—	—	< 1	0.33
Pinus contorta var. *latifolia*	A	20	45	15	1.00
	B	30	15	3	1.00
	D	5	1	—	0.67
Total[c] tree layer	**All**	**50**	**60**	**35**	**1.00**
Shrubs					
Juniperus communis	B	—	1	1	0.67
Paxistima myrsinites	B	—	—	2	0.33
Rosa acicularis	B	1	< 0.5		0.67
Salix sp.	B	—	T	—	0.33
Shepherdia canadensis	B	< 1	< 0.5	T	1.00
Vaccinium membranaceum	B	—	—	3	0.33
Vaccinium scoparium	B	—	—	5	0.33
Total[c] shrub layer	**B**	**2**	**1.5**	**6**	**1.00**
Herbs					
Achillea millefolium	C	T	T	—	0.67
Arctostaphylos uva-ursi	C	12	15	—	0.67
Epilobium angustifolium	C		T	—	0.33
Fragaria virginiana	C	—	T	—	0.33
Grass spp.	C	< 1	—	—	0.33
Empetrum nigrum	C	—	—	< 1	0.33
Linnaea borealis	C	—	< 1	—	0.33
Pyrola asarifolia	C	—	< 0.5	—	0.33
Solidago spathulata	C	< 1	—	—	0.33
Total[c] herb layer	**C**	**13**	**15**	**5**	**1.00**
Mosses, lichens, liverworts, and seedlings					
Cladina spp.	D	—	1	12	0.67
Cladonia spp.	D	3	1	25	1.00
Cladonia pyxidata	D	3	1	25	1.00
Dicranum fuscescens	D	—	2	20	0.67
Peltigera spp.	D	3	10	2	1.00
Peltigera aphthosa	D	—	10	2	0.67
Pogonatum alpinum	D	—	—	5	0.33
Polytrichum spp.	D	2	—	—	0.33
Stereocaulon spp.	D	2	1	6	1.00
Stereocaulon paschale	D	—	1	—	0.33
Total[c] moss, lichen, liverwort, and seedling layer	**D**	**10**	**15**	**70**	**1.00**

a A = tree layer: includes dominant, co-dominant, and sub-canopy trees > 10 m in height; B = shrub layer: includes both tall and low shrubs < 10 m in height; C = herb layer; and D = moss, lichen, liverwort, and seedling layer (British Columbia Ministry of Environment, Lands and Parks and British Columbia Ministry of Forests 1998).

b Constancy refers to the proportion of plots in which the species were found.

c "Total" is the visual percent cover estimate, not the addition of all species percent cover.

d "T" = trace

TABLE 4 *Summary of the vegetation data for the Bella Coola Valley pine mushroom study plots (percent cover)*

Species	Layer[a]	Plot B-1	Plot B-2	Plot B-3	Constancy[b]
Trees					
Pinus contorta var. *latifolia*	A	—	—	10	0.33
	D	T[d]	—	—	0.33
Pseudotsuga menziesii ssp. *menziesii*	A	75	80	7	1.00
	B	10	15	38	1.00
Tsuga heterophylla	D	—	T	T	0.67
Thuja plicata	B	—	10	—	0.33
Total[c] tree layer	**All**	**85**	**85**	**55**	**1.00**
Shrubs					
Acer glabrum	B	—	15	—	0.33
Amelanchier alnifolia	B	1.5	< 1	1	1.00
Paxistima myrsinites	B	< 1	—	—	0.33
Rosa gymnocarpa	B	—	1.5	—	0.33
Shepherdia canadensis	B	< 1	—	< 0.5	0.67
Sorbus scopulina	B	—	—	< 0.5	0.33
Symphoricarpos albus	B	—	—	1	0.33
Vaccinium membranaceum	B	—	—	2	0.33
Vaccinium parvifolium	B	—	—	T	0.33
Vaccinium scoparium	B	—	—	4	0.33
Total[c] shrub layer	**B**	**2**	**17**	**4**	**1.00**
Herbs					
Aralia nudicaulis	C	—	2	—	0.33
Arctostaphylos uva-ursi	C	—	—	4	0.33
Arnica cordifolia	C	—	T	—	0.33
Chimaphila umbellata	C	—	—	3	0.33
Epilobium angustifolium	C	T	—	—	0.33
Grass spp.	C	< 1	< 0.5	—	0.67
Hieracium albiflorum	C	T	—	—	0.33
Linnaea borealis	C	—	—	3	0.33
Melampyrum lineare	C	—	—	T	0.33
Streptopus roseus	C	—	T	—	0.33
Total[c] herb layer	**C**	**<1**	**2**	**14**	**1.00**
Moss, lichen, liverwort, and seedling layer					
Cladonia spp.	D	—	—	T	0.33
Dicranum fuscescens	D	2	—	—	0.33
Hylocomium splendens	D	2	30	10	1.00
Pleurozium schreberi	D	1.5	—	45	0.67
Pogonatum alpinum	D	—	—	2	0.33
Rhytidiadelphus triquetrus	D	1.5	45	30	1.00
Total[c] moss, lichen, liverwort, and seedling layer	**D**	**7**	**75**	**85**	**1.00**

a A = tree layer: includes dominant, co-dominant, and sub-canopy trees > 10 m in height; B = shrub layer: includes both tall and low shrubs < 10 m in height; C = herb layer; and D = moss, lichen, liverwort, and seedling layer (British Columbia Ministry of Environment, Lands and Parks and British Columbia Ministry of Forests 1998).

b Constancy refers to the proportion of plots in which the species were found.

c "Total" is the visual percent cover estimate, not the addition of all species percent cover.

d "T" = trace

present in all but one of the plots (B-2). *Amelanchier alnifolia*, while similarly low in cover, was present in all the valley plots.

There were no obvious trends among the plots in the species of herbs found. Of the mosses and lichens, *Cladonia pyxidata* was common to all plateau plots, while *Hylocomium splendens* and *Rhytidiadelphus triquetrus* were common to all valley plots.

Nakusp

Vegetation communities were very similar at these three plots (Table 5) with one-half of all listed species found in all three plots.

The tree layer in plots N-1 and N-2 consisted of Douglas-fir (*Pseudotsuga menziesii* var. *glauca*) with western redcedar (*Thuja plicata*) and western hemlock. A small amount of western white pine (*Pinus monticola*) occurred in the tree layer of plot N-1. The overstorey in and around plot N-3 consisted primarily of western hemlock with some western white pine and western redcedar. Average age of the dominant and co-dominant stems was 110 years. In terms of percent cover suppressed, western redcedar and western hemlock were the main lower canopy species found within all three plots and averaged 76 years old. Western larch (*Larix occidentalis*) occurred in the overstorey of plots N-1 and N-3.

Plot N-2 was located adjacent to a 1988 clearcut and had been subjected to at least two minor windthrow events, which eliminated much of the dominant overstorey. The most prevalent vegetation within plot N-3 was an extremely dense patch of western hemlock advanced regeneration, which occurred in the centre of the plot.

The basal area of merchantable stems within the plots was 60 m^2 in N-1, 40m^2 in N-2, and 36m^2 in N-3.

A limited variety of shrub species was present in the sampled areas, with small amounts of *Paxistima myrsinites* and *Rosa gymnocarpa* found in all three plots. Small patches of *Taxus brevifolia* were located in and around plot N-1 and *Vaccinium* species were relatively prolific in plot N-2 (approximately 6% cover).

Mosses dominated the forest floor, particularly *Pleurozium schreberi*, which was found in all three plots. Small amounts of various herb species also occupied the understorey, with *Linnaea borealis*, *Chimaphila umbellata*, *Adenocaulon bicolor*, *Clintonia*

TABLE 5 *Summary of the vegetation data for the Nakusp pine mushroom study plots (percent cover)*

Species	Layer[a]	Plot N-1	Plot N-2	Plot N-3	Constancy[b]
Trees					
Pseudotsuga menziesii var. *glauca*	A[c]	20	20	—	0.67
	B[c]	1	—	—	0.33
	C[c]	1	—	—	0.33
	D[c]	1	—	—	0.33
Larix occidentalis	A	2	—	3	0.67
Thuja plicata	A	10	15	5	1.00
	B	2	5	2	1.00
	C	1	2	5	1.00
	D	1	2	2	1.00
Tsuga heterophylla	A	25	5	20	1.00
	B	5	3	15	1.00
	C	2	2	25	1.00
	D	1	3	3	1.00
Pinus monticola	A	2	—	10	0.67
	B	—	—	1	0.33
Betula papyrifera	A	—	1	—	0.33
Shrubs					
Paxistima myrsinites	B	< 1	< 1	1	1.00
Rosa gymnocarpa	B	< 1	< 1	< 1	1.00
Taxus brevifolia	B	2	—	—	0.33
Vaccinium membranaceum	B	—	< 1	—	0.33
Vaccinium ovalifolium	B	—	5	—	0.33
Herbs					
Adenocaulon bicolor	C	2	5	< 1	1.00
Chimaphila umbellata	C	5	1	2	1.00
Clintonia uniflora	C	1	2	1	1.00
Cornus canadensis	C	2	1	< 1	1.00
Goodyera oblongifolia	C	—	—	1	0.33
Linnaea borealis	C	2	4	< 1	1.00
Orthilia secunda	C	5	—	—	0.33
Pteridium aquilinum	C	< 1	—	—	0.33
Moss, lichen, liverwort, and seedling layer					
Pleurozium schreberi	D	20	20	20	1.00
Rhytidiopsis robusta	D	5	10	—	0.67

a A = tree layer: includes dominant, co-dominant, and sub-canopy trees > 10 m in height; B = shrub layer: includes both tall and low shrubs < 10 m in height; C = herb layer; and D = moss, lichen, liverwort, and seedling layer (British Columbia Ministry of Environment, Lands and Parks and British Columbia Ministry of Forests 1998).

b Constancy refers to the proportion of plots in which the species were found.

c Within the tree layer only: A = trees > 17.5 cm dbh (diameter at breast height); B = trees (Poles) 7.5–17.5 cm dbh; C = trees (Advanced Regeneration) 1.3 m in height, 7.5 cm dbh; D = trees (Regeneration) < 1.3 m in height.

uniflora, and *Cornus canadensis* the most frequent species encountered.

Nahatlatch and Pemberton

The transition between continental and maritime climates in the study areas was noticeable in the composition of the vegetation communities on the Nahatlatch (Table 6) and Pemberton (Table 7) plots. On the leeward side of the Coastal Range, the westernmost fringe of the continental climate is strongly influenced by the maritime weather systems. Typical of this sort of climatic transition, the vegetation was a blend of both continental and maritime indicator species. Generally, the layers showed fairly high species diversity. In addition, plots NH-2, and P-1 and P-3 also fell within the transition area between IDFww and CWHds1 biogeoclimatic subzones. The resulting plant communities were quite diverse in structure.

Canopy closure of the tree layer was near complete (97% or higher) in all of the Pemberton plots. The Nahatlatch plots were significantly more open, with NH-2 and NH-3 showing fairly dense tree layers (75% and 85%) while NH-1 had a very thin stand with a canopy closure of 53%. Douglas-fir was present in all plots and was the leading tree species in all but two. In plot P-1 the principal tree species was western hemlock, indicative of the CWHds1 subzone. In plot NH-2, lodgepole pine was the main tree species. Western hemlock was present at lower percent covers in all but two plots (NH-1 and P-3), both of which were strongly characteristic of IDFww. Western redcedar was also present as a minor component of three plots and as a leading component of P-2. Subalpine fir (*Abies lasiocarpa*) occurred in plot NH-3. The only deciduous tree present in the tree layer was paper birch (*Betula papyrifera*), a species common in the wetter IDF subzones, which occurred as a minor or trace component of all three Pemberton plots.

The total percent cover of tree species in the shrub layer ranged between 15% and 45%. Douglas-fir was present in all plots. Western hemlock was absent only from NH-1 and western redcedar was absent only from NH-2. Spruce (*Picea* spp.) occurred in all but NH-2. Amabilis fir (*Abies amabilis*) occurred only in plots P-1 and P-2. The only deciduous tree found in the shrub layer was paper birch, which occurred only in plots P-1

TABLE 6 *Summary of the vegetation data for the Nahatlatch River pine mushroom study plots (percent cover)*

Species	Layer[a]	Plot NH-1	Plot NH -2	Plot NH-3	Constancy[b]
Trees					
Abies lasiocarpa	A	—	—	1	0.33
	B	—	—	6	0.33
	D	—	—	T[d]	0.33
Juniperus communis	B	T	—	—	0.33
Picea engelmannii	A	—	—	< 1	0.33
	B	T	—	< 1	0.67
	D	—	T	—	0.33
Pinus contorta var. *latifolia*	A	6	70	—	0.67
	B	T	1	—	0.67
Pinus monticola	A	—	—	T	0.33
	B	T	T	—	0.67
	D	T	—	—	0.33
Pseudotsuga menziesii var. *glauca*	A	42	9	69	1.00
	B	12	23	< 1	1.00
	D	T	T	T	1.00
Taxus brevifolia	B	—	—	< 1	0.33
	D	—	—	T	0.33
Thuja plicata	A	7	—	2	0.67
	B	12	—	6	0.67
Tsuga heterophylla	A	—	< 1	24	0.67
	B	—	3	16	0.67
	D	T	T	T	1.00
Total[c] tree layer		**73**	**85**	**88**	**1.00**
Shrubs					
Acer circinatum	B	< 1	—	—	0.33
Acer glabrum	B	T	1	T	1.00
Alnus viridis ssp. *crispa*	B	—	—	< 1	0.33
Amelanchier alnifolia	B	T	<1	T	1.00
Arctostaphylos uva-ursi	B	3	T	T	1.00
Chimaphila menziesii	C	T	T	—	0.67
Chimaphila umbellata	C	1.3	T	< 1	1.00
Corylus cornuta	B	< 1	—	—	0.33
Lonicera ciliosa	B	T	—	—	0.33
Mahonia aquifolium	B	< 1	—	—	0.33
Menziesia ferruginea	B	—	2	—	0.33
Paxistima myrsinites	B	T	T	6	1.00
Prunus emarginata	B	1	—	—	0.33
Ribes lacustre	B	—	—	T	0.33
Rosa gymnocarpa	B	< 1	—	—	0.33
Rosa nutkana	B	< 1	—	—	0.33
Rubus parviflorus	B	T	—	—	0.33

TABLE 6 *Continued*

Species	Layer[a]	Plot NH-1	Plot NH-2	Plot NH-3	Constancy[b]
Shrubs (continued)					
Salix sp.	B	—	T	—	0.33
Sorbus scopulina	B	—	—	< 1	0.33
Spiraea betulifolia	B	< 1	—	—	0.33
Vaccinium membranaceum	B	< 1	<1	<1	1.00
Vaccinium ovalifolium	B	—	T	—	0.33
Vaccinium parvifolium	B	—	T	—	0.33
Total[c] shrub layer		9	5	8	1.00
Herbs					
Antennaria racemosa	C	T	—	—	0.33
Apocynum androsaemifolium	C	T	—	—	0.33
Castilleja sp.	C	T	T	—	0.67
Clintonia uniflora	C	T	—	—	0.33
Cornus canadensis	C	1	—	—	0.33
Epilobium angustifolium	C	—	—	T	0.33
Fragaria virginiana	C	T	—	—	0.33
Goodyera oblongifolia	C	T	—	< 1	0.67
Hieracium albiflorum	C	T	—	—	0.33
Linnaea borealis	C	1.6	< 1	< 1	1.00
Lycopodium complanatum	C	T	—	—	0.33
Orthilia secunda	C	T	—	1	0.67
Pteridium aquilinum	C	1.1	—	—	0.33
Pyrola asarifolia	C	T	—	—	0.33
Pyrola picta	C	T	T	T	1.00
Pyrola sp.	C	—	T	—	0.33
Total[c] herb layer		4	<1	2	1.00
Moss, lichen, liverwort, and seedling layer					
Andraea rupestris	D	—	< 1	—	0.33
Aulocomnium androgynum	D	T	—	T	0.67
Barbilophozia floerkii	D	T	14	—	0.67
Barbilophozia sp.	D	—	< 1	T	0.67
Brachythecium leibergii	D	—	—	T	0.33
Brachythecium sp.	D	—	—	T	0.33
Cladina sp.	D	< 1	4	—	0.67
Cladonia sp.	D	0.07	3	T	1.00
Dicranum pallidisetum	D	—	—	< 1	0.33
Dicranum scoparium	D	—	—	T	0.33
Dicranum sp.	D	1.2	18	—	0.67
Drepanocladus uncinatus	D	—	T	T	0.67
Dryptodon patens	D	—	—	T	0.33
Heterocladium procumbens	D	—	—	T	0.33

TABLE 6 *Concluded.*

Species	Layer[a]	Plot NH-1	Plot NH-2	Plot NH-3	Constancy[b]
Moss, lichen, liverwort, and seedling layer (continued)					
Hylocomium splendens	D	1.4	5	< 1	1.00
Hypnum circinale	D	—	T	< 1	0.67
Kindbergia oregana	D	T	—	—	0.33
Lobaria pulmonaria	D	—	T	—	0.33
Mnium spinulosum	D	T	—	< 1	0.67
Nephroma sp.	D	—	—	T	0.33
Peltigera britannica	D	< 1	1	1	1.00
Peltigera neopolydactyla	D	T	—	—	0.33
Peltigera sp.	D	—	T	—	0.33
Plagiochila asplenioides	D	—	—	T	0.33
Pleurozium schreberi	D	17	13	< 1	1.00
Polytrichum juniperinum	D	< 1	< 1	T	1.00
Polytrichum piliferum	D	—	T	—	0.33
Pterigynandrum filiforme	D	—	—	T	0.33
Ptilidium ciliare	D	T	15	—	0.67
Ptilium californicum	D	—	—	T	0.33
Racomitrium sp.	D	—	7	—	0.33
Racomitrium heterostichum	D	—	—	T	0.33
Rhytidiadelphis loreus	D	—	T	—	0.33
Rhytidiadelphis triquetrus	D	< 1	T	—	0.67
Rhytidiopsis robusta	D	T	< 1	4	1.00
Timmia austriaca	D	—	—	< 1	0.33
Tortula ruralis	D	—	—	T	0.33
Trachybryum megaptilum	D	< 1	—	—	0.33
Umbilicaria sp.	D	—	T	—	0.33
Total[c] moss, lichen, liverwort and seedling layer		22	80	8	1.00

a A = tree layer: includes dominant, co-dominant, and sub-canopy trees > 10 m in height; B = shrub layer: includes both tall and low shrubs < 10 m in height; C = herb layer; and D = moss, lichen, liverwort, and seedling layer (British Columbia Ministry of Environment, Lands and Parks and British Columbia Ministry of Forests 1998).

b Constancy refers to the proportion of plots in which the species were found.

c "Total" is the visual percent cover estimate, not the addition of all species percent cover.

d "T" = trace

TABLE 7 *Summary of the vegetation data for the Pemberton pine mushroom study plots (percent cover)*

Species	Layer[a]	Plot P-1	Plot P-2	Plot P-3	Constancy[b]
Trees					
Abies amabilis	B	T[d]	< 1	—	0.67
Abies lasiocarpa	B	—	—	< 1	0.33
Betula papyrifera	A	6	< 1	10	1.00
	B	< 1	—	< 1	0.67
Picea engelmannii	B	—	< 1	—	0.33
Picea sitchensis	B	T	—	2	0.67
Pinus contorta var. *latifolia*	A	—	—	2	0.33
Pinus monticola	A	3	—	—	0.33
	B	—	2	—	0.33
	D	—	< 1	—	0.33
Pseudotsuga menziesii var. *glauca*	A	7	64	86	1.00
	B	10	2	11	1.00
	D	T	T	T	1.00
Taxus brevifolia	B	—	—	< 1	0.33
Thuja plicata	A	18	43	—	0.67
	B	11	36	< 1	1.00
	D	T	—	—	0.33
Tsuga heterophylla	A	87	20	—	0.67
	B	27	10	2	1.00
	D	< 1	T	T	1.00
Total[c] tree layer		**99**	**99**	**97**	**1.00**
Shrubs					
Acer glabrum	B	T	—	T	0.67
Amelanchier alnifolia	B	< 1	T	< 1	1.00
Chimaphila menziesii	C	—	—	T	0.33
Chimaphila umbellata	C	1	3	1	1.00
Cornus stolonifera	B	< 1	—	—	0.33
Corylus cornuta	B	—	—	6	0.33
Lonicera ciliosa	B	—	—	< 1	0.33
Mahonia aquifolium	B	T	T	1	1.00
Paxistima myrsinites	B	< 1	6	< 1	1.00
Prunus emarginata	B	< 1	—	—	0.33
Ribes sp.	B	T	—	—	0.33
Ribes lacustre	B	T	—	—	0.33
Rosa gymnocarpa	B	T	T	1	1.00
Rubus parviflorus	B	< 1	—	< 1	0.67
Shepherdia canadensis	B	—	—	T	0.33
Sorbus scopulina	B	—	—	< 1	0.33
Spiraea betulifolia	B	—	T	< 1	0.67
Symphoricarpus albus	B	T	—	—	0.33
Vaccinium membranaceum	B	T	< 1	1	1.00
Total[c] shrub layer		**3**	**9**	**13**	**1.00**

TABLE 7 *Continued*

Species	Layer[a]	Plot P-1	Plot P-2	Plot P-3	Constancy[b]
Herbs					
Clintonia uniflora	C	T	< 1	1	1.00
Cornus canadensis	C	—	< 1	—	0.33
Disporum hookeri	C	T	T	1	1.00
Goodyera oblongifolia	C	T	T	T	1.00
Hieracium albiflorum	C	—	—	T	0.33
Hypopitys monotropa	C	—	—	T	0.33
Linnaea borealis	C	—	< 1	2	0.67
Lycopodium complanatum	C	—	T	—	0.33
Orthilia secunda	C	T	T	T	1.00
Osmorhiza chilensis	C	—	—	T	0.33
Pyrola asarifolia	C	—	< 1	< 1	0.67
Pyrola picta	C	T	T	< 1	1.00
Pyrola sp.	C	—	T	—	0.33
Tiarella unifoliata	C	—	T	—	0.33
Trientalis latifolia	C	—	—	1	0.33
Viola sp.	C	—	T	—	0.33
Total[c] herb layer		**<1**	**1**	**5**	**1.00**
Moss, lichen, liverwort, and seedling layer					
Aulocomnium androgynum	D	—	—	T	0.33
Calypogaea sp.	D	T	—	—	0.33
Cladonia sp.	D	T	T	—	0.67
Dicranum pallidisetum	D	3	2	—	0.67
Hylocomium splendens	D	28	4	7	1.00
Kindbergia oregana	D	<1	—	—	0.33
Lobaria pulmonaria	D	—	< 1	—	0.33
Mnium spinulosum	D	< 1	< 1	—	0.67
Peltigera aphthosa	D	T	< 1	—	0.67
Peltigera britannica	D	T	< 1	—	0.67
Pleurozium schreberi	D	2	2	1	1.00
Ptilidium crista-castrensis	D	< 1	1	—	0.67
Rhytidiadelphis loreus	D	—	< 1	—	0.33
Rhytidiadelphis triquetrus	D	1	2	9	1.00
Rhytidiopsis robusta	D	9	2	< 1	1.00
Total[c] moss, lichen, liverwort, and seedling layer		**43**	**14**	**18**	**1.00**

a A = tree layer: includes dominant, co-dominant, and sub-canopy trees > 10 m in height; B = shrub layer: includes both tall and low shrubs < 10 m in height; C = herb layer; and D = moss, lichen, liverwort, and seedling layer (British Columbia Ministry of Environment, Lands and Parks and British Columbia Ministry of Forests 1998).

b Constancy refers to the proportion of plots in which the species were found.

c "Total" is the visual percent cover estimate, not the addition of all species percent cover.

d "T" = trace

and P-3. Tree seedling cover in the moss, lichen, liverwort, and seedling layer was minimal, with a trace of both western hemlock and Douglas-fir in all of the plots and rare occurrences of other species.

The shrub layer was rich in species diversity in most plots, although the mean percent cover was only 8%. *Paxistima myrsinites*, *Vaccinium membranaceum*, *Chimaphila umbellata*, and *Amelanchier alnifolia* were present in all plots. Plot P-2 had a relatively low number of shrub species, of which *P. myrsinites* and *C. umbellata* were the most prevalent, with only traces of other species. *Paxistima myrsinites* was also the main species in the shrub layer of plot NH-3.

The herb layer was most diverse in the three IDFww plots (P-2, P-3, NH-1), with 12–14 species present within the plot boundaries, as compared with only 4–5 species present within the CWH plots. Within the three CWH plots (P-1, NH-2, NH-3), the diversity was lower and the percent cover was also lower at approximately 1.3%. Mean percent cover for the six plots was 2%. *Pyrola picta* was the only species to occur in all six plots, although *Orthilia secunda*, *Linnaea borealis*, and *Goodyera oblongifolia* were each represented in five of the plots.

The moss, lichen, liverwort, and seedling layer exhibited a similar contrast in diversity between the IDFww and CWH plots. The CWH plots (P-1, NH-2, NH-3) had high species diversity (16–24 species). In contrast, the IDFww sites had 5–12 species, with plot P-3 having a very limited moss, lichen, and liverwort community. Percent cover ranged from 8 to 80% with a mean for the six plots of 31%; the highest moss, lichen, and liverwort cover was at the CWHds1 sites. *Hylocomium splendens*, *Pleurozium schreberi*, and *Rhytidiopsis robusta* were present in dominant and co-dominant percent covers in all the plots. *Dicranum* sp. and *Ptilidium ciliare* were significant components of the moss, lichen, and liverwort layer in plot NH-2. At lower percent cover values, but occurring in five of the plots, were *Peltigera britannica* and *Rhytidiadelphis triquetrus*.

Some taxonomic challenges were encountered during the fieldwork. The *Ribes* sp. may be *R. laxiflorum* and the *Brachythecium* sp. may be *B. albicans*. The *Dicranum* sp. specimen for plot NH-1 included *D. pallidisetum* and *D. scoparium*, while the *Dicranum* sp. specimen for plot NH-2 included *D. pallidisetum*, *D. scoparium*, and *D. fuscescens*. The *Dryptodon patens* specimen also included *Dicranoweisia crispa*. The *Racomitrium* sp. may be *R. elongatum* or *R. ericoides*.

Nass River

In general, the soils were deep, well to rapidly drained, and coarse textured, and had relatively thin forest floors (Appendix 1). Soil moisture and nutrient regimes were drier and poorer, respectively, than the zonal concepts. These characteristics are inherent given the nature of the coarse, water-worked parent materials, and the fire history; frequently occurring intense fires can deplete sites of nutrients. Given the proximate location of the old village of Aiyansh, this area (particularly plots NS-1 and NS-2) may have also been subject to repeated prescribed fire over many centuries.

The S layer (a distinct soil surface layer of living bryophytes [Green et al. 1993]) was an almost continuous bryophytic vegetative layer with litter lying on top of, or intermixed with, the mosses. The Fm horizons were characteristic of Hemimor humus forms and were relatively thin (3–4 cm). The fabric was compact-matted, with slightly to moderately decomposed fibric material making up the bulk of the matrix, with abundant white and grey fungal mycelia. Fine and medium roots were abundant, with coarse roots found mostly at the mineral interface. Charcoal found at the mineral soil interface indicated that fire was the most recent disturbance factor in succession. At times, pockets or layers of abundant white to grey fungal mycelia (mats) were evident at the forest floor–mineral soil interface; these had the appearance of Ae horizons.

In the upper mineral soil profile, Ae horizons were weakly developed in plots NS-1 and NS-2, but strongly developed in plot NS-3. The subsurface horizons were remarkably similar in all the plots. The Bm and podzolic Bf horizons were identified using colour criteria in the field, and were verified later by chemical analyses. The upper B horizons were a strong-coloured brown in the 7.5YR hue, and of loamy sand texture with 30–35% coarse fragments. The lower B horizons were a more neutral hue (10YR) of yellow-brown colours; the percent coarse fragment content increased with depth. Effective rooting was normally near the boundary to the transitional BC horizons at depths of approximately 30–40 cm. The soil structure in the B horizons was very weak, medium, sub-angular blocky, but clearly apparent when

compared to the structureless, single-grain C horizons found about 60 cm in depth. The soil genesis and properties would indicate shallow leaching and deposition of amorphous organic matter, iron, and aluminum, but not as intense as would be found in adjacent coastal or higher-elevation forests.

Chilcotin Plateau and Bella Coola Valley

Mineral soil development indicated, for the most part, relatively shallow leaching and deposition of amorphous organic matter, iron, and aluminum (Appendices 2 and 3).

All humus forms were classified as Hemimors. The sites have a history of repeated wildfire, which has resulted in relatively thin forest floors. Soil crusts were observed on plot C-1, and this plot showed evidence of the most recent and extreme effects from wildfire. It was also the driest of all the described sites. Three of the sites had thin Ah horizons. An S layer was present only in the plots located in the CWHds2.

The mineral soils were all coarse textured and well to rapidly drained. Mineral soil structure was generally weak due to the coarse textures and low organic matter content. The soils were classified as either Orthic Dystric Brunisols or Orthic Humo-Ferric Podzols, except for plot B-1, which was classified as an Orthic Eutric Brunisol due to a pH of 5.6 in the Bm1 horizon. Surface Ae and Ah mineral horizons were hydrophobic, with abundant fungal mycelium.

Soil moisture regimes ranged from 2 to 3 (subxeric to submesic) and soil nutrient regimes ranged from B to C (submesotrophic to mesotrophic). Soil samples generally indicated acid conditions (pH of 5.5 or lower). Mineralizable N concentrations ranged from zero to 771 ppm.

Nakusp

In general, the soils sampled were deep and rapidly drained with thin forest floors (averaging 4.9 cm) (Appendix 4). All landforms and soils were initiated through glacial and glacio-lacustrine processes and have been modified by hydrologic weathering and infrequent wildfire events as evidenced by fire-killed snags and charcoal deposits in the humus layers.

All soils within the plots were classified as Eluviated Dystric

Brunisols, which are characterized by the presence of a Bm layer and a well-developed Ae layer, a pH of less than 5.5 for the upper 25 cm of the profile, and the absence of either an Ah layer or mottling.

The forest floor layers consisted of well-defined L, F, and H layers. The L layer consisted mainly of coniferous needles and small (< 3 mm diameter) twigs. Large woody debris was scattered over and within the L layer and represented approximately 15% of all litter. The F layers were all thick (usually > 50% of the total LFH thickness) and matted with abundant grey mycelium displayed throughout. The H layers were all extremely thin (< 0.5 cm) and contained abundant mycelium. The majority of rooting activity within all the soil pits occurred at the interface between the H layer and the mineral soil. The thick F layers were diagnostic of Hemimor humus forms and consisted of more than 70% of the combined thickness of the F and H layers.

In the mineral soil profile, Ae layers were well developed in all three plots. Considerable variation in the texture, colour, and structure of all the various Bm layers was found. The Bm layer in plot N-1 had a light red-brown colour with a silty texture and a very weak platy structure, while the same layer in plot N-2 had a light yellow-brown colour with a sandy loam texture and a weak blocky structure. The Bm layer at plot N-3 had a light brown colour with a loamy sand texture and an unconsolidated structure.

Transitional BC layers were located in plots N-1 and N-2. In plot N-1, the BC layer was poorly defined with a gradual change in colour that diffused into the underlying C layer. A sporadic BCc layer in plot N-2 had the characteristics of a poorly defined duric horizon. This compacted horizon had a slightly higher pH than the surrounding soil horizons. At only 3.8 cm thick, the BCc horizon was not thick enough to be classified as a true duric horizon and has, therefore, not been taken into consideration during the classification of the soil on this site.

The C layers within all three plots were derived from granitic parent material, which contributed to the overall acidity (pH 3.5–4.7) of the soils.

Nahatlatch and Pemberton

In general, the soils were deep and the forest floor was thin (Table 1). The soils were well drained with a large component of

coarse fragments. Soil textures included sandy loam, loamy sand, sand, and silty loam. Plots NH-2 and NH-3 both had a significant proportion of colluvial surficial material.

DISCUSSION AND CONCLUSIONS

LIMITATIONS OF THE STUDY

Although all of the stands studied for this report were recommended by knowledgeable, local, commercial mushroom pickers as being representative of productive pine mushroom habitat, mushroom productivity was not assessed in any of them. Five to ten years of intensive fieldwork would be needed to determine reliable mushroom productivity figures. This approach is not without risk; however, when weighed against the technical and financial hurdles associated with mushroom productivity research, the likelihood of getting reliable habitat data by using local expertise was deemed high.

In each of the six areas of the province that were studied, only three stands were described. In addition, there are as yet undescribed areas of the province, such as southeastern Vancouver Island, where pine mushrooms are harvested commercially. Clearly, more research is required to fully encompass the range of habitat favoured by pine mushroom.

Despite these limitations, the habitat information included in this report is a good starting point. Subsequent work supports this belief. In the Prince Rupert Forest Region, 21 highly productive pine mushroom sites have been studied using the same approach and the results support and expand on what has been included in this report (Trowbridge and Macadam 1998).

CHARACTERISTICS OF PINE MUSHROOM HABITAT

Forest stands containing productive pine mushroom habitat were found to occupy a variety of biogeoclimatic settings spanning eight different subzones or variants (Table 1) in five biogeoclimatic zones: Interior Cedar-Hemlock (ICH), Sub-boreal Pine–Spruce (SBPS), Engelmann Spruce–Subalpine Fir (ESSF), Interior Douglas-fir (IDF), and Coastal Western Hemlock (CWH). Elevation, slope, aspect, and landform varied widely, but soil moisture and nutrient regimes tended to fall within a relatively narrow range. Soil moisture was in most cases

drier than average for the subzone (2–3), and was wetter than mesic (5) in only two plots; however, based on the other soil attributes recorded for these two plots, the rating for soil moisture regime may have been too wet. Consequently, the soil moisture regime should be re-examined for these plots. Soil nutrient regimes also fell almost exclusively within the range of poor to medium (B–C). Soils tended to be well or rapidly drained, and were in most cases very coarse in texture (sand to loamy sand), often with high coarse fragment contents. Forest floors tended to be relatively thin, and humus forms were classified as Hemimors. A common feature of the soils was the presence of an Ae horizon, or grey-white mycelium, which could be mistaken for an Ae horizon. Wildfire was the most common natural disturbance regime.

Canopy closure varied considerably among plots. Western hemlock (*Tsuga heterophylla*) had the highest constancy among tree species, appearing in all but the Chilcotin plots. Dominant tree species were either lodgepole pine (*Pinus contorta* var. *latifolia*), Douglas-fir (*Pseudotsuga menziesii* var. *glauca*), or western hemlock. The only deciduous tree species encountered was paper birch (*Betula papyrifera*), mainly in the Pemberton study area. Shrub species tended to have relatively low cover values, but included four species (two of them dwarf shrubs) that occurred in over 60% of plots examined (i.e., constancy values greater than 0.60): *Chimaphila umbellata*, *Paxistima myrsinites*, *Vaccinium membranaceum*, and *Linnaea borealis*. Herb cover was low in general, and was extremely low in several cases. *Goodyera oblongifolia* was the herb species encountered most frequently, with a constancy value of 0.50. Moss percent cover was highly variable, ranging from 7 to 97%. Three species had constancy values of greater than 0.60: *Pleurozium schreberi*, *Hylocomium splendens*, and *Rhytidiopsis robusta*.

RECOMMENDATIONS

The studies initiated as part of this project have been expanded to include 21 more sites in the Prince Rupert Forest Region known to be highly productive pine mushroom sites (Trowbridge and Macadam 1998). The Northwest Institute for Bioregional Research has also completed work evaluating pine mushroom and timber production in the Cranberry Timber

Supply Area and the extent of potential pine mushroom habitat in the Kispiox and Kalum Small Business Forest Enterprise Programs (Northwest Institute for Bioregional Research 1999). Both the Kalum and Kispiox forest districts are mapping the extent of the submesic ICH areas, as this ecological work and that of Trowbridge and Macadam (1998) have pinpointed these sites as potential pine mushroom patches (Kranabetter 1999; M. Kranabetter, Prince Rupert Region soil scientist, pers. comm., 1999). In these districts, this ecological information can now be used for planning purposes.

In forest districts where pine mushroom is important, the information provided in this report could be used to verify and expand on local pine mushroom habitat characterization, similar to the work undertaken by the Prince Rupert Forest Region. With reliable regional habitat information for pine mushroom, important site types could be mapped and then integrated into forest planning.

APPENDIX 1 Soil profile descriptions for the Nass River pine mushroom study sites

PLOT NS-1 SOIL PROFILE DESCRIPTION

Horizon	Depth (cm)	Description
S/L	(2)	Bryophyte layer dominated by *Pleurozium schreberi* and *Hylocomium splendens*, intermixed with individual particles of newly accreted litter (leaves, needles, twigs, and cones).
Fm1	4–1	Compact-matted; slightly decomposed fibric material; abundant fine and medium roots.
Fm2	1–0	Matted and tenacious; abundant grey and white mycelia resembling an Ae horizon in colour; abundant charcoal at interface.
Bf	0–18	Strong brown (7.5YR 4/6, moist); loamy sand; 30% coarse fragments; very weak sub-angular blocky to single grain; plentiful to abundant fine, medium, and coarse roots; clear, wavy boundary.
(Ae)	(pocket)	Light brownish grey (10YR 6/2, moist); loamy sand; 30% coarse fragments; very weak sub-angular blocky to single grain; few fine and medium roots; abrupt, broken boundary.
Bm	18–38	Dark yellowish brown (10YR 4/5, moist); sand; 40% coarse fragments; very weak sub-angular blocky to single grain; plentiful medium, few fine and coarse roots; clear, smooth boundary.
BC	38–62	Brown to dark brown (10YR 3.5/3, moist); sand; 80% coarse fragments (60% stones); single grain, few fine roots; gradual smooth boundary.
C	62+	Dark greyish brown (2.5Y 4/2, moist); 50+% coarse fragments; single grain, very few to occasional fine roots; also in turbated area left side, mid-profile.

APPENDIX 1 *Continued*

PLOT NS-1 SOIL CHEMICAL PROPERTIES BY HORIZON[a]

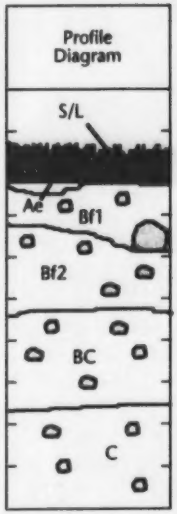
Horizon	Total C (%)	C/N (ratio)	CEC	Exch. Ca	Exch. K	Exch. Mg	Total N (%)	Min. N	Available P	Fe (pyro)	Al (pyro)	pH ($CaCl_2$)
			(Meq/100 g)					(ppm)		(%)		
Fm1and 2	39.87	53.16	42.69	24.97	2.66	5.45	0.75	128.6	69.4	0.241	0.235	3.79
Bf	1.26	14.85	8.57	0.07	0.07	0.02	0.08	1.6	64.2	0.283	0.385	4.53
Bm	1.15	15.63	7.94	0.15	0.05	0.01	0.07	0.8	85.6	0.112	0.238	4.87
BC	0.73	10.85	6.71	0.13	0.05	0.00	0.07	0.8	94.9	0.102	0.22	5.08
C	0.60	9.35	5.25	0.16	0.03	0.02	0.06	0.7	98.8	0.131	0.265	5.08

a Level of precision, as represented by the significant digits, is presented as reported by the Ministry of Forests Research Branch for all soil chemistry in this report

APPENDIX 1 *Continued*

PLOT NS-2 SOIL PROFILE DESCRIPTION

Horizon	Depth (cm)	Description
S/L	(2)	Bryophyte layer dominated by *Pleurozium schreberi* and *Hylocomium splendens*, intermixed with individual particles of newly accreted litter (leaves, needles, twigs, and cones).
Fm1	4–3	Compact-matted and tenacious; slightly decomposed fibric material; abundant fine and medium roots.
Fm2	3–0	Matted, moderately decomposed; abundant grey and white mycelia with some yellow mycelium near decaying wood; common, medium charcoal at interface; abundant fine and medium roots; 10% decaying wood.
Ae	0–1	Light brownish grey (10YR 6/2, dry); loamy sand; 25% coarse fragments; very weak to moderate sub-angular blocky, to single grain; abundant grey and white mycelia contributing to colour; few fine and medium roots; abrupt, smooth boundary.
Bf1	1–14	Strong brown (7.5YR 4/6, moist); loamy sand; 30% coarse fragments; very weak sub-angular blocky to single grain; small patches of grey and white mycelia; plentiful to abundant fine, medium, and coarse roots; clear, smooth boundary.
Bf2	14–32	Brown to dark brown (10YR 4/3, moist); sand; 40% coarse fragments; very weak to moderate sub-angular blocky, to single grain; plentiful medium, few fine and coarse roots; clear, smooth boundary.
BC	32–54	Light olive brown (2.5YR 5/4, moist); sand; 50% coarse fragments; single grain, very few fine roots; gradual smooth boundary.
C	54–60+	Dark greyish brown (2.5Y 4/2, moist); 55% coarse fragments; single grain.



APPENDIX 1 *Continued*

PLOT NS-2 SOIL CHEMICAL PROPERTIES BY HORIZON[a]

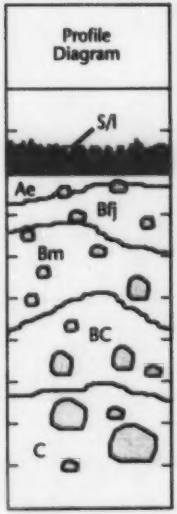
Horizon	Total C (%)	C/N (ratio)	CEC	Exch. Ca	Exch. K	Exch. Mg	Total N (%)	Min. N	Available P	Fe (pyro)	Al (pyro)	pH ($CaCl_2$)
			(Meq/100 g)					(ppm)		(%)		
Fm1 and 2	42.66	93.17	42.19	3.47	3.06	2.09	0.46	7.7	121.6	0.275	0.276	3.25
Bf1	1.20	12.05	10.16	0.00	0.19	0.01	0.10	4.0	110.8	0.42	0.602	3.95
Bf2	0.37	4.95	5.65	0.02	0.07	0.01	0.08	0.9	50.7	0.136	0.276	4.72
BC	0.35	5.02	5.15	0.02	0.06	0.00	0.07	0.6	44.3	0.105	0.221	4.94
C	0.33	5.22	4.89	0.03	0.04	0.00	0.06	0.2	30.5	0.085	0.18	4.84

a Level of precision, as represented by the significant digits, is presented as reported by the Ministry of Forests Research Branch for all soil chemistry in this report.

APPENDIX 1 *Continued*

PLOT NS-3 SOIL PROFILE DESCRIPTION

Horizon	Depth (cm)	Description
S/L	(2)	Bryophyte layer dominated by *Rhytidiopsis robusta*, *Hylocomium splendens*, and *Pleurozium schreberi*, intermixed with individual particles of newly accreted litter (leaves, needles, twigs, and cones).
Fm	0–3	Compact-matted and tenacious, slightly to moderately decomposed fibric material, abundant fine and medium roots; abundant grey and white mycelia; no charcoal present.
Ae	0–5	Light brownish grey (10YR 6/2, moist); sandy loam; 20% coarse fragments; weak fine sub-angular blocky to single grain; abundant fine and medium roots; very hydrophobic due to mycelia; abrupt, smooth to broken (discontinuous) boundary.
Bfj	5–17	Brown to strong brown (7.5YR 5/5, moist); loamy sand to sand; 35% coarse fragments; weak, fine sub-angular blocky to single grain; plentiful to abundant fine, medium and coarse roots; clear, wavy boundary.
Bm	17–32	Dark yellowish brown (10YR 4/6, moist); loamy sand to sand; 40% coarse fragments; weak fine sub-angular blocky to single grain; abundant fine and medium roots; clear, wavy boundary.
BC	32–53	Brown (10YR 5/3, moist); loamy sand; 45% coarse fragments (60% stones); weak fine sub-angular blocky; few fine roots; gradual smooth boundary.
C	53–60+	Yellowish brown (10YR 5/4, moist); loamy sand; 45% coarse fragments; single grain, very few fine roots.



APPENDIX 1 *Concluded.*

PLOT NS-3 SOIL CHEMICAL PROPERTIES BY HORIZON[a]

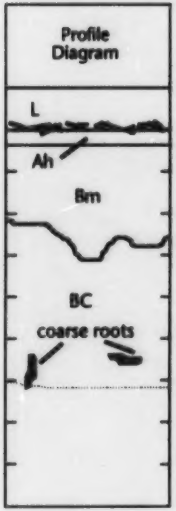
Horizon	Total C (%)	C/N (ratio)	CEC	Exch. Ca	Exch. K	Exch. Mg	Total N (%)	Min. N	Available P	Fe (pyro)	Al (pyro)	pH ($CaCl_2$)
			(Meq/100 g)					(ppm)		(%)		
Fm	51.33	53.34	45.85	10.47	4.60	4.41	0.96	24.3	122.6	0.261	0.154	3.74
Ae	3.09	39.35	18.09	0.32	0.27	0.50	0.08	1.1	2.0	0.210	0.153	3.35
Bfj	1.01	13.36	9.18	0.04	0.19	0.06	0.08	0.8	23.7	0.211	0.382	4.67
Bm	0.69	9.8	6.83	0.06	0.11	0.05	0.07	1.1	43.9	0.114	0.236	5.03
BC	0.31	6.76	4.69	0.09	0.06	0.05	0.05	0.6	56.5	0.118	0.218	5.17
C	0.31	4.71	4.50	0.09	0.07	0.11	0.07	0.8	41.7	0.144	0.205	4.81

a Level of precision, as represented by the significant digits, is presented as reported by the Ministry of Forests Research Branch for all soil chemistry in this report.

APPENDIX 2 Soil profile descriptions for the Chilcotin Plateau pine mushroom study sites

PLOT C-1 SOIL PROFILE DESCRIPTION

Horizon	Depth (cm)	Description
L	0.5–0	Bryophyte layer dominated by lichens, intermixed with individual particles of newly accreted lodgepole pine litter (mostly needles) and "soil crusts." F horizon lacking due to frequent, repeated wildfire.
Ah	0–2	Very dark greyish brown (10YR 3/2.5, moist); sand; 0% coarse fragments; single grain; very few fine roots; abrupt, smooth boundary.
Bm	2–24	Brown (10YR 5/3, moist); sand; 0% coarse fragments; single grain; few fine and plentiful medium roots; gradual, wavy boundary.
BC	24–60+	Greyish brown (10YR 4/5, moist); sand; 0% coarse fragments; single grain; few medium and coarse roots



APPENDIX 2 *Continued*

PLOT C-1 SOIL CHEMICAL PROPERTIES BY HORIZON[a]

Horizon	Total C (%)	C/N (ratio)	CEC (Meq/100 g)	Exch. Ca (Meq/100 g)	Exch. K (Meq/100 g)	Exch. Mg (Meq/100 g)	Total N (%)	Min. N (ppm)	Available P (ppm)	Fe (pyro) (%)	Al (pyro) (%)	pH ($CaCl_2$)
L	45.92	69.85	ins[b]	ins	ins	ins	0.66	143.9	40.4	0.005	0.052	3.68
Ah	1.83	28.72	6.11	2.70	0.14	0.18	0.06	5.9	111.7	0.082	0.153	5.02
Bm	0.28	23.78	2.79	0.93	0.13	0.16	0.01	0.0	99.9	0.088	0.147	5.25
BC	0.10	22.88	3.09	2.07	0.16	0.40	0.00	0.0	21.7	0.050	0.058	5.66

a Level of precision, as represented by the significant digits, is presented as reported by the Ministry of Forests Research Branch for all soil chemistry in this report.

b ins = insufficient quantity of sample to permit analysis.

APPENDIX 2 *Continued*

PLOT C-2 SOIL PROFILE DESCRIPTION

Horizon	Depth (cm)	Description
L	2.5–2	Litter layer dominated by lichens with particles of newly accreted lodgepole pine litter (mostly needles).
Fm	2–0	Mostly moderately decomposed needles with abundant grey mycelium.
Ae	0–8	Light brownish grey (10YR 6.5/2, dry); sand; 3% coarse fragments (part of one stone); single grain; abundant grey mycelia; very few fine and plentiful coarse roots; abrupt, smooth boundary.
Bm	8–30	Strong brown (10YR 5.5/6, moist); sand; 3% coarse fragments (part of one stone); single grain; patches of iron staining; few fine and plentiful medium and coarse roots; clear, smooth boundary.
BC	30–50	Yellowish brown (10YR 5/4, moist); sand; < 1% coarse fragments; single grain; few medium and coarse roots; abrupt, smooth boundary.
IIBC	50–60	Yellowish brown (10YR 5/4, moist); sand; 30% coarse fragments; single grain; few medium and coarse roots.

APPENDIX 2 *Continued*

PLOT C-2 SOIL CHEMICAL PROPERTIES BY HORIZON[a]

Horizon	Total C (%)	C/N (ratio)	CEC (Meq/100 g)	Exch. Ca (Meq/100 g)	Exch. K (Meq/100 g)	Exch. Mg (Meq/100 g)	Total N (%)	Min. N (ppm)	Available P (ppm)	Fe (pyro) (%)	Al (pyro) (%)	pH ($CaCl_2$)
FF[b]	51.37	45.52	72.88	22.68	1.82	4.04	1.13	388.3	40.0	0.020	0.104	3.73
Ae	0.64	30.86	7.53	0.87	0.29	0.21	0.02	0.0	365.4	0.206	0.369	4.26
Bm	0.20	22.92	3.96	0.96	0.21	0.25	0.01	0.0	46.2	0.165	0.182	4.54
BC	0.12	12.64	3.62	1.26	0.24	0.33	0.01	0.0	42.9	0.118	0.142	4.75
IIBC	0.09	16.08	3.06	1.48	0.26	0.4	0.01	0.0	17.5	0.060	0.061	4.91

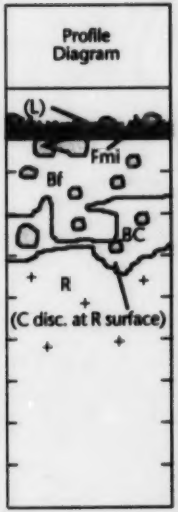
a Level of precision, as represented by the significant digits, is presented as reported by the Ministry of Forests Research Branch for all soil chemistry in this report.

b FF means "forest floor," which is a composite of all surface organic horizons.

APPENDIX 2 *Continued*

PLOT C-3 SOIL PROFILE DESCRIPTION

Horizon	Depth (cm)	Description
(L)		Scattered, discontinuous lodgepole pine needles and fine branches.
Fmi	2–0	Very slight, compact-matted, slightly to moderately decomposed fibric material intermixed with mineral grains; gravels and stones at surface; plentiful fine and medium roots; abundant grey mycelium; common to abundant charcoal present.
Bf	0–20	Dark brown (7.5YR 3/4, moist); loamy sand; 45% coarse fragments; plentiful fine and medium roots; clear, wavy boundary.
BC	20–30	Dark yellowish brown (10YR 4/4, moist); loamy sand; 50% coarse fragments; plentiful fine and medium roots; abrupt, wavy boundary.
(C)	(30–35)	Dark greyish brown (10YR 4/2, moist); loamy sand; 65% coarse fragments (discontinuous basil till, compact and hard).
R	30+	Andesite bedrock



APPENDIX 2 *Concluded.*

PLOT C-3 SOIL CHEMICAL PROPERTIES BY HORIZON[a]

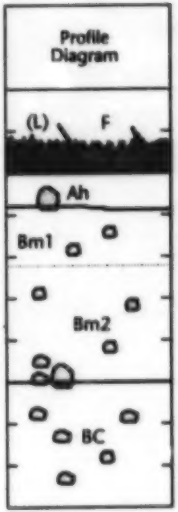
Horizon	Total C (%)	C/N (ratio)	CEC	Exch. Ca	Exch. K	Exch. Mg	Total N (%)	Min. N	Available P	Fe (pyro)	Al (pyro)	pH ($CaCl_2$)
			(Meq/100 g)					(ppm)		(%)		
Fmi	37.31	33.91	66.06	13.06	1.85	1.97	1.10	243.3	33.8	0.192	0.362	3.82
Bf	3.62	33.67	17.67	0.86	0.15	0.12	0.11	0.0	10.6	0.290	0.799	5.05
BC	1.00	25.01	10.14	0.20	0.06	0.05	0.04	0.0	29.2	0.093	0.428	5.29

a Level of precision, as represented by the significant digits, is presented as reported by the Ministry of Forests Research Branch for all soil chemistry in this report.

APPENDIX 3 Soil profile descriptions for the Bella Coola Valley pine mushroom study sites

PLOT B-1 SOIL PROFILE DESCRIPTION

Horizon	Depth (cm)	Description
(L)	(< 0.5)	Mostly Douglas-fir needles and fine branches.
Fm	6–0	Very dry, moderately decomposed fibric material; plentiful fine and medium roots; abundant white and grey mycelium; moderately decomposed decaying wood 5–30%, forest floor as little as 1–2 cm in plot.
Ah	0–8	Very dark greyish brown (10YR3/3, moist); loamy sand; 25% coarse fragments; plentiful fine and medium roots; hydrophobic with abundant mycelium; clear, smooth boundary.
Bm1	8–22	Dark brown (10YR 3/3, moist); loamy sand; 35% coarse fragments; weak, fine sub-angular blocky; few fine and medium roots; gradual, smooth boundary.
Bm2	20–50	Dark brown (10YR 3.5/3, moist); loamy sand; 45% coarse fragments; weak, medium sub-angular blocky; few fine and medium roots; abrupt to clear, smooth boundary.
BC	50–70+	Greyish brown (2.5YR 5/2, moist); loamy sand; 50% coarse fragments; very weak, medium sub-angular blocky; very few medium roots



APPENDIX 3 *Continued*

PLOT B-1 SOIL CHEMICAL PROPERTIES BY HORIZON[a]

Horizon	Total C (%)	C/N (ratio)	CEC	Exch. Ca	Exch. K	Exch. Mg	Total N (%)	Min. N	Available P	Fe (pyro)	Al (pyro)	pH ($CaCl_2$)
			(Meq/100 g)					(ppm)		(%)		
FF[b]	47.53	55.75	61.77	27.07	2.46	4.00	0.85	0.0	87.5	0.009	0.034	3.89
Ah	5.26	38.65	25.27	14.33	0.57	1.11	0.14	9.0	222.1	0.303	0.458	5.44
Bm1	1.26	26.75	6.33	2.94	0.19	0.26	0.05	3.6	95.7	0.177	0.268	5.59
Bm2	0.65	22.39	5.28	1.53	0.17	0.16	0.03	0.0	96.1	0.071	0.123	5.37
BC	0.43	22.8	3.45	0.81	0.12	0.15	0.02	0.0	51.8	0.082	0.198	4.90

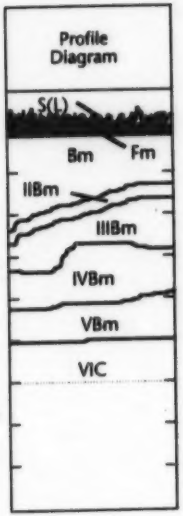
a Level of precision, as represented by the significant digits, is presented as reported by the Ministry of Forests Research Branch for all soil chemistry in this report.

b FF means "forest floor," which is a composite of all surface organic horizons.

APPENDIX 3 *Continued*

PLOT B-2 SOIL PROFILE DESCRIPTION

Horizon	Depth (cm)	Description
S(L)	1.5	*Hylocomium splendens* and *Rhytidiadelphus triquetrus* mosses, intermixed with Douglas-fir and western redcedar litter; Douglas-fir cones have abundant white mycelium.
Fm	2–0	Slightly compact-matted, moderately decomposed fibric material; abundant white and grey mycelium.
Bm	0–15	Very dark greyish brown (10YR 5/2, dry); sand; 0% coarse fragments; single grain; few, fine and medium roots; abrupt, smooth boundary.
IIBm	15–21	Dark greyish brown (10YR 4/2, moist); very fine sandy loam; 0% coarse fragments; very weak, medium, sub-angular blocky; few fine and plentiful medium roots; abrupt, smooth boundary.
IIIBm	21–26	Light brownish grey (10YR 6/2, dry); sand; 0% coarse fragments; very weak, medium, sub-angular blocky; few fine and plentiful medium roots; abrupt, smooth boundary.
IVBm	26–40	Dark greyish brown (10YR 4/2, moist); very fine sandy loam; 0% coarse fragments; very weak, medium, sub-angular blocky; few fine and plentiful medium roots; abrupt, smooth boundary.
VBm	40–50	Greyish brown (10YR /2, dry); fine sand; 0% coarse fragments; very weak, medium, sub-angular blocky; few fine and plentiful medium roots; abrupt, smooth boundary.
VIC	50–60+	Dark greyish brown (10YR 4/2, moist); very fine sandy loam; 0% coarse fragments; somewhat compact, massive to single grain; few medium roots; abrupt, smooth boundary.



APPENDIX 3 *Continued*

PLOT B-2 SOIL CHEMICAL PROPERTIES BY HORIZON[a]

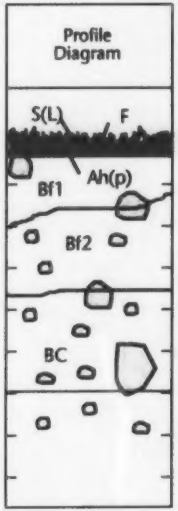
Horizon	Total C (%)	C/N (ratio)	CEC	Exch. Ca	Exch. K	Exch. Mg	Total N (%)	Min. N	Available P	Fe (pyro)	Al (pyro)	pH ($CaCl_2$)
			(Meq/100 g)					(ppm)		(%)		
Fm	44.24	34.26	76.4	49.86	3.30	5.61	1.29	770.5	79.0	0.018	0.040	4.74
Bm	0.28	25.85	4.70	2.72	0.13	0.41	0.01	0.1	56.8	0.066	0.087	5.10
IIBm	1.16	21.76	10.13	5.31	0.23	0.65	0.05	6.3	93.0	0.194	0.241	5.19
IIIBm	0.29	18.00	4.96	2.88	0.12	0.40	0.02	0.0	46.1	0.087	0.109	5.22
IVBm	0.52	21.46	6.42	3.88	0.13	0.58	0.02	0.0	36.3	0.137	0.144	5.19
VBm	0.35	22.65	6.11	3.89	0.14	0.60	0.02	1.4	45.9	0.089	0.111	5.17
VIC	0.46	19.46	6.53	3.14	0.09	0.33	0.02	2.9	185.2	0.243	0.251	5.06

a Level of precision, as represented by the significant digits, is presented as reported by the Ministry of Forests Research Branch for all soil chemistry in this report.

APPENDIX 3 *Continued*

PLOT B-3 SOIL PROFILE DESCRIPTION

Horizon	Depth (cm)	Description
S(L)	2	Dominantly *Pleurozium schreberi* and *Rhytidiadelphus triquetrus* mosses intermixed with few needles and fine branches.
Fm	2–0	Slightly compact-matted, slightly decomposed fibric material comprised of mosses with few needles and cones; common to abundant yellow, white, and grey mycelium; common fine to medium charcoal.
Ah(p)	0–2	Very dark brown (10YR 2/2, moist); loamy sand; 35% coarse fragments; few fine and medium roots; abundant grey mycelium; abrupt, smooth boundary. An intermixed horizon, likely due from repeated fire and possibly human disturbance. Hydrophobic.
Bf1	2–16	Dark brown (10YR 3/3, moist); sand; 40% coarse fragments; few fine and plentiful medium roots; abundant grey mycelia; clear, smooth boundary. Hydrophobic.
Bf2	16–38	Brown (7.5YR 5/4, dry); sand; 55% coarse fragments; few fine roots; iron straining in matrix and on coarse fragments; clear, smooth boundary.
BC	38–60	Light yellowish brown (10YR 6/4, dry); sand; 65% coarse fragments; very few fine roots; iron staining in matrix and on coarse fragments.



APPENDIX 3 *Concluded.*

PLOT B-3 SOIL CHEMICAL PROPERTIES BY HORIZON[a]

Horizon	Total C (%)	C/N (ratio)	CEC	Exch. Ca	Exch. K	Exch. Mg	Total N (%)	Min. N	Available P	Fe (pyro)	Al (pyro)	pH ($CaCl_2$)
			(Meq/100 g)					(ppm)		(%)		
Fm	41.99	37.69	74.70	23.25	2.30	4.18	1.11	399.0	85.8	0.075	0.129	3.86
Ah(p)	6.07	29.18	20.72	3.37	0.28	0.65	0.21	35.8	76.1	0.335	0.199	3.97
Bf1	2.40	28.52	13.42	0.49	0.09	0.14	0.08	10.6	147.4	0.378	0.321	4.02
Bf2	0.85	24.59	7.60	0.49	0.04	0.14	0.03	2.0	223.1	0.333	0.516	4.52
BC	0.24	22.51	3.48	0.48	0.04	0.14	0.01	0.0	87.8	0.087	0.160	4.68

a Level of precision, as represented by the significant digits, is presented as reported by the Ministry of Forests Research Branch for all soil chemistry in this report.

APPENDIX 4 Soil profile descriptions for the Nakusp pine mushroom study sites

PLOT N-1 SOIL PROFILE DESCRIPTION

Horizon	Depth (cm)	Description
Ae	0–1.5	Grey[a]; silty loam; 0% coarse fragments.
Bm	1.5–19.5	Red brown; silty loam; 30% coarse fragments.
Bc	19.5–24.0	Light brown; silty loam; 65% coarse fragments.
C	24.0+	Grey; silty loam; 45% coarse fragments.

a Colour has been determined through visual interpretation only.

SOIL CHEMICAL PROPERTIES BY HORIZON[a]

Horizon	Total C (%)	C/N (ratio)	CEC (Meq/100 g)	Exch. Ca (Meq/100 g)	Exch. K (Meq/100 g)	Exch. Mg (Meq/100 g)	Total N (%)	Min. N (ppm)	Available P (ppm)	Fe (pyro) (%)	Al (pyro) (%)	pH ($CaCl_2$)
Ae	2.47	38.1	2.74	ins[b]	ins	ins	0.06	ins	46.0	ins	ins	ins
Bm	2.18	27.0	13.4	2.25	0.23	0.36	0.08	22.0	4.7	0.10	0.32	5.26
BC	0.31	31.3	2.86	0.83	0.11	0.48	0.01	2.3	8.1	0.09	0.08	4.77
C	0.28	32.6	2.68	1.12	0.09	0.56	0.01	0.2	6.6	0.07	0.05	4.73

a Level of precision, as represented by the significant digits, is presented as reported by the Ministry of Forests Research Branch for all soil chemistry in this report.

b ins = insufficient quantity of sample to permit analysis.

APPENDIX 4 *Continued*

PLOT N-2 SOIL PROFILE DESCRIPTION

Horizon	Depth (cm)	Description
Ae	0–1.6	Grey; sandy loam; 0% coarse fragments.
Bm	1.6–17.6	Light brown; sandy loam; 25% coarse fragments.
Bcc	17.6–17.6	Grey; loam; 50% coarse fragments.
C	17.6+	Grey; sandy loam; 30% coarse fragments.

SOIL CHEMICAL PROPERTIES BY HORIZON[a]

Horizon	Total C (%)	C/N (ratio)	CEC	Exch. Ca	Exch. K	Exch. Mg	Total N (%)	Min. N	Available P	Fe (pyro) (%)	Al (pyro) (%)	pH ($CaCl_2$)
			(Meq/100 g)					(ppm)				
Ae	2.30	41.92	2.69	ins[b]	ins	ins	0.05	ins	0.6	ins	ins	ins
Bm	0.85	29.55	4.20	2.00	0.05	0.28	0.03	13.3	5.6	0.155	0.095	4.89
Bcc	0.28	36.22	2.40	1.83	0.05	0.31	0.01	3.0	0.4	0.048	0.023	5.67
C	0.46	35.61	3.18	2.14	0.07	0.36	0.01	5.2	0.5	0.092	0.043	5.52

a Level of precision, as represented by the significant digits, is presented as reported by the Ministry of Forests Research Branch for all soil chemistry in this report.

b ins = insufficient quantity of sample to permit analysis.

APPENDIX 4 *Concluded.*

PLOT N-3 SOIL PROFILE DESCRIPTION

Horizon	Depth (cm)	Description
Ae	0–2.0	Grey; loamy sand; 0% coarse fragments.
Bm	2.0–20	Light brown; loamy sand; < 10% coarse fragments.
C	20+	Light brown; loamy sand; < 10% coarse fragments.

SOIL CHEMICAL PROPERTIES BY HORIZON[a]

Horizon	Total C (%)	C/N (ratio)	CEC	Exch. Ca	Exch. K	Exch. Mg	Total N (%)	Min. N	Available P	Fe (pyro)	Al (pyro)	pH ($CaCl_2$)
			(Meq/100 g)					(ppm)		(%)		
Ae	0.85	29.30	3.62	0.00	0.07	0.00	0.03	5.1	30.4	0.04	0.03	3.46
Bm	0.81	22.3	6.22	0.62	0.11	0.08	0.04	5.0	117	0.11	0.03	5.06
C	0.25	31.3	2.07	0.51	0.12	0.07	0.01	0.0	118	ins	ins	5.15

a Level of precision, as represented by the significant digits, is presented as reported by the Ministry of Forests Research Branch for all soil chemistry in this report.
b ins = insufficient quantity of sample to permit analysis.

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